

DETAILED ACTION

Response to Amendment

In the 4/10/08 submission, claims 1, 3-5, 8, 14 are currently amended, while the other claims 2, 6-7, 9-13, 15-19 remain as original. Claims 1-19 remain under consideration.

The previous specification objections (1)-(2), the previous rejection of claim 5 under the second paragraph of 35 U.S.C. 112, the previous double patenting and ODP rejections over Lin (US Patent 6,010,807), as well as various previous art rejections under 35 U.S.C. 101, 102, 103 of the instant claims are each withdrawn in view of the current amendment including a terminal disclaimer (TD for the Lin patent only) and accompanying remarks, which are found persuasive.

However, the current amendment has also necessitated new specification objection(s) and rewritten ground(s) of rejection, each as set forth below. This Office action is made FINAL.

Specification

The disclosure is objected to, because of at least the following informalities: (3) in paragraph 16/lines 3-4 and paragraph 20/L3-4,10, the current amendment use of symbols in the phrases “ π -shift end portion” and “ $\pi/2$ -shift region” at each occurrence are inconsistent and confusing with respect to the previous use of different symbols in the remaining phrases “ δ -shift end portion” and “ $\delta/2$ -shift region”, respectively, as exemplified in paragraph 9/L1,4 and paragraph 19/L1,5. While it is recognized in the art of phase shift masks (PSMs) that a phase shift (PS) of π radians is the same as a PS of 180° (which is the PS of the transparent end portion 210a as illustrated in Figure 2 and described in paragraph 13/L5), the specification must be clear and consistent in the use of symbols to represent the amount of PS for items 210a and 230.

Appropriate correction is required.

Terminal Disclaimer

The terminal disclaimer (TD) filed on 4/10/08 disclaiming the terminal portion of any patent granted on the instant application, which would extend beyond the expiration date of US Patent 6,010,807 (Lin) has been reviewed and is accepted. The TD has been recorded.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 1-7 and 14-19 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for features actually shown by instant Figure 2 (as described by paragraphs 13-21 of the original specification), the specification does not reasonably provide enablement for the full scope of the currently added language to (A) *claim 1/L8-9* and (B) *claim 14/L6-7*. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make or use the invention commensurate in scope with these claims.

In each of (A) *claim 1/L8-9* and (B) *claim 14/L6-7*, the currently added language “no phase shift region is present between any two neighboring dense linear patterns”, at each occurrence, is not fully supported by the original specification since it is inconsistent with the express disclosure of phase shift (PS) region 230 between dense line patterns 220 on opposite sides of 230, as illustrated in Figure 2 (described by paragraphs 13-21) of the original specification. Claims 2-7 depend from claim 1 and claims 15-19 depend from claim 14.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 8-13 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter, which Applicant regards as the invention.

In (C) *claim 8/L3-5*, it is unclear whether the currently amended language “including a transparent end portion with a phase shift of 180° relative to the substrate *without a phase shift region adjacent to two sides thereof*” (emphasis provided by italics for the currently added text) refers to (a) the (transparent) substrate of the PSM or (b) only the transparent end portion (with a 180° PS) of the isolated linear pattern. However, for the purpose of this Office action, this language is interpreted to read as follows: --including a transparent end portion with a phase shift of 180° relative to the substrate, wherein the transparent end portion is *without a phase shift region adjacent to two sides thereof*--, in accordance with (b) above.

In (D) *claim 8/L6-7*, the currently added text “*end of an isolated linear photoresist pattern defined by the isolated linear pattern in a lithography process* **is covered by the transparent end portion in the lithography process**” (emphasis provided by italics for the currently added text) is also unclear. For the purpose of this Office action, this text is interpreted to be --*end of an isolated linear photoresist pattern* is defined by the isolated linear pattern in a lithography process, and the end of the isolated linear photoresist pattern corresponds to ~~is covered by~~ the transparent end portion in the lithography process--. Claims 9-13 depend from claim 14.

Claim Rejections - 35 USC § 102 or 103

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

The following is a quotation of 35 U.S.C. 103(a), which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 8-9, 11, and 13 are rejected under 35 U.S.C. 102(e) as being anticipated by Yang (US 2005/0048377).

Yang teaches a multi-transmittance photomask (such as a multi-transmittance halftone phase shift mask, HTPSM) along with materials and methods for fabricating it to improve lithography performance (title, abstract). This HTPSM includes patterns having regions of different transmittance for the purpose of reducing one or more of line edge shortening (line end shortening, LES), iso-to-dense bias, and edge-to-dense bias. Regions of denser or longer lines can be constructed to have a lower transmittance than regions of isolated lines (abstract). Figures 1-3 illustrate masks having patterns with different densities or lengths on the same transparent quartz substrate [0028], [0029], [0031]-[0034] (*instant claim 9*). The semi-transparent halftone

material provides a PS of 180° [0034], [0035] (*instant claim 11*). In Figure 6, a comparison of photoresist pattern profiles for Mask 1 on the right to that on the left shows that the iso-to-dense bias and the line end shortening (LES) of the isolated line 60 can be improved (by reducing the LES) when semi-transparent transmittance is increased from 6% (as shown in the isolated line 60 of the mask on the left in Figure 6) to 24% (as shown for the isolated line 65 on the right in Figure 6, [0037]). Figure 11 shows another example of reduced line end shortening (LES) in resulting photoresist patterns by increasing semi-transparent transmittance from 6% to 24% for a pair of opposite isolated linear patterns 1 and 4 with their transparent end portions facing each other on the mask [0043] (*instant claims 8 and 13*).

Claims 10 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yang (US 2005/0048377) and Okamoto (US 5,358,807).

Yang does not specifically teach that the isolated linear pattern on the PSM includes an opaque material except for its transparent end portion (*instant claim 10*) or that the transparent end portion of the isolated linear pattern on the PSM includes a recessed portion of the substrate (*instant claim 12*).

However, it has been known for some time that using a transparent end portion groove or recessed portion of the substrate adjacent to an opaque line pattern on a mask improves resolution of the line pattern when it is transferred onto a wafer, as taught by Okamoto (abstract). Okamoto teaches a mask and a method of manufacturing the mask (title). The mask is exemplified by a phase shift mask (PSM, abstract) having a 180-degree PS recessed groove 7a (transparent end portion with a 180° PS) of depth "d" in substrate 2 between a transparent portion (unetched substrate) in region B and the edge of pattern A(3) including an end of a linear (e.g.,

isolated, etc.) portion made from a metal layer 3, as illustrated by Figures 6 and 7 (c9/L39 to c10/L15). The substrate 2 is transparent quartz glass and the metal layer 3 is chromium (Cr) or Cr oxide on Cr for the light shielding (opaque) region A (c6/L27-42, *instant claims 10 and 12*).

It would have been obvious to one of ordinary skill in the art at the time of the invention in the PSM having an isolated linear pattern with a semi-transparent end portion of increased transmittance for reducing line-end-shortening (LES, as taught by Yang) to further increase the end portion transmittance of an opaque isolated linear pattern on the PSM by forming the end portion as a transparent 180° PS recess in the PSM substrate (as taught by Okamoto), because the use of a transparent 180° PS recess in the PSM substrate as the end portion of an opaque isolated linear pattern on the PSM has been known for some time to improve resolution of the isolated opaque line pattern when it is transferred onto a wafer (as taught by Okamoto).

Claims 14-16 are rejected under 35 U.S.C. 102(b) as being anticipated by Hsu (US 2003/0077519).

Hsu teaches an alternative phase shifting mask (PSM) that cancels phase conflict (title, [0002]). As illustrated in Figure 7 and front page Figure 8, this PSM has a transparent substrate 40 with light shielding (opaque, e.g., chrome (Cr), etc.) linear layer (dense) regions 45 (*instant claim 16*), each end (portion) of which has an adjacent 90° PS (within the range of 85° to 95° PS) translucent layer 49 (reading on the instant transparent 90° PS region). There is no PS (0° non-PS) present in each transparent region 46 between two neighboring dense linear pattern regions 45 (reading on the *instant claim 14* for no PS region being present between two neighboring dense linear patterns). Each 0° non-PS transparent region is formed on the transparent substrate at 40a, as shown in Figure 7 ([0025], [0026]). The transparent substrate 40 material is

exemplified as being quartz, which is also the same material for the transparent substrate 10 in prior art Figure 1 ([0022] lines 4-7, *instant claim 15*) and the wholly transparent region 24 (0° non-PS) of the substrate 20 in the halftone PSM (att-PSM) depicted in prior art Figure 2a [0007]. In this att-PSM of Figure 2a, the attenuated transparent regions 22 (MoSiON with a transparency of only 4% to 10% (clearly semi-transparent), 180° PS) are used as the (dense) linear patterns to make the contrast clearer between the wholly transparent region 24 (0° non-PS) and the attenuated transparent region 22 (180° PS), so that resolution of the exposure process can be improved (as indicated in Figure 2c, [0007]).

Claim 17 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hsu (US 2003/0077519).

Hsu (as discussed above) does not specifically teach that the Figure 8 PSM dense linear patterns 45 each include a layer of semi-transparent material with a PS of 180°.

However, it would still have been obvious to one of ordinary skill in the art at the time of the invention to use a layer of semi-transparent material with a PS of 180° for the Figure 8 PSM dense linear patterns 45 taught by Hsu, because doing so would be reasonably expected to succeed in clearer contrast and improved exposure resolution (as taught by Hsu [0007], which is described above, *instant claim 17*).

Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hsu (US 2003/0077519) and Chapple-Sokol et al. (US 5,465,859).

Hsu (as discussed above) does not specifically teach that the Figure 8 PSM transparent 90° PS end adjacent region 49 includes a recessed portion of the transparent substrate 40.

Nevertheless, it has been known for some time that a transparent 90° PS region can be achieved on a PSM by etching a recess of an appropriate depth in the transparent substrate of the PSM (subtractive method) instead of adding an appropriate thickness of transparent PS material onto the substrate (additive method) to form the transparent 90° PS region, as exemplified by Chapple-Sokol et al. In this reference, a subtractive method is taught for making a PSM that includes etching transparent 90° PS regions in a transparent quartz substrate 25, with the known advantages for this subtractive method that include precise etch depth control, self-aligned phase error correction, and reduced sidewall scattering (c1/L42-44, c1/L57 to c2/L23, c4/L1). In Figure 2a, a PSM is shown that has 90° PS strips or regions 20 at the ends of neighboring dense linear patterns on both sides of a central 0° (non-PS) transparent region (c3/L51-61). The recessed 90° ($\pi/2$) PS regions are more clearly shown as 28, 29, 30, 31 in the side view of Figure 2e (c4/L19-22), as well as 38, 39, 40 in the side view of Figure 2i (c4/L32-35).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to make the Figure 8 PSM transparent 90° PS end adjacent region 49 (as taught by Hsu) by a subtractive etching method so that the 90° PS end adjacent region includes a recessed portion of the transparent substrate 40, because of the known advantages for such a subtractive method that include precise etch depth control, self-aligned phase error correction, and reduced sidewall scattering when etching the 90° PS recess in the transparent substrate of the PSM (as taught by Chapple-Sokol et al.).

Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hsu (US 2003/0077519) and Yang (US 2005/0048377).

Hsu does not specifically teach two groups of dense linear patterns separated by a transparent 90° PS region adjacent to the ends of the dense linear patterns.

The teachings of Yang are discussed above.

It would have been obvious to one of ordinary skill in the art at the time of the invention to utilize the Figure 8 PSM having dense linear patterns 45 (e.g., of semi-transparent material for 180° PS, etc.) with transparent 90° PS regions 49 adjacent to the ends of the dense linear patterns 45 (as taught by Hsu) so that the dense linear patterns have adjusted transmittance when they are positioned with their transparent end portions facing each other (as in the PSM shown by Figure 11 of Yang), because doing so would be reasonably expected to reduce line end shortening (LES) of the opposite dense linear patterns positioned with their transparent end portions facing each other (as taught by Yang, *instant claim 19*).

Claims 1-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Admitted Prior Art (AAPA, instant Figure 1), Okamoto (US 5,358,807), Hsu (US 2003/0077519), Yang (US 2005/0048377), and Chapple-Sokol et al. (US 5,465,859).

While showing the combination of oppositely positioned corresponding isolated and dense linear patterns of semi-transparent (halftone) 180° PS material (e.g., on a transparent substrate, etc.) of a halftone PSM (as shown by instant prior art Figure 1, [0006]), AAPA does not specifically teach other aspects of *instant claims 1-7* (as individually referenced below).

The teachings of Okamoto, Hsu, Yang, and Chapple-Sokol et al. are discussed above.

It would have been obvious to one of ordinary skill in the art at the time of the invention in the combination of a pair of oppositely positioned corresponding isolated linear patterns (*instant claim 6*) and two groups of oppositely positioned corresponding dense linear patterns

(*instant claim 7*) made of semi-transparent (halftone) 180° PS material (e.g., on a transparent substrate, etc.) for a halftone PSM (as shown by AAPA) to use a transparent substrate of quartz or glass (as is notoriously well known in the art and exemplified above by at least Okamoto, Lin, Hsu, and Yang, *instant claim 2*) along with isolated and dense linear patterns that include either opaque layers (as taught by Okamoto or Hsu, *instant claim 3*) or semi-transparent layers with a PS of 180° (as taught by AAPA, Hsu, or Yang, *instant claim 4*) on the transparent substrate, wherein the isolated pattern has a transparent end portion with a PS of 180° (as taught by AAPA, Okamoto, and Yang), wherein the transparent PS region adjacent to the ends of the dense linear patterns has a PS of 90° (as taught by Hsu and Chapple-Sokol et al.), wherein the transparent 180° PS end portion of the isolated pattern and the transparent 90° PS region (adjacent to the ends of the dense linear patterns) each comprise a recessed portion of the transparent substrate (as taught by Okamoto, Hsu, and Chapple-Sokol et al., *instant claim 5*), and wherein no PS region is present between two neighboring dense linear patterns (as taught by Hsu, *instant claim 1*), in order to achieve the known benefit(s) for each of these aspects (as exemplified by at least these references, which are each discussed in the rejections set forth above).

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the “right to exclude” granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

Claims 1-19 are provisionally rejected on the ground of nonstatutory obviousness-type double patenting (ODP) as being unpatentable over claims 1-8 of copending Application No. 11/161,084 (Shieh et al., corresponding to US 2007/0020532, which has a common assignee (United Microelectronics Corp. of Taiwan) with the instant application) in combination with Applicant's Admitted Prior Art (AAPA, instant Figure 1), Okamoto (US 5,358,807), Hsu (US 2003/0077519), Yang (US 2005/0048377), and Chapple-Sokol et al. (US 5,465,859). Although the conflicting claims are not identical, they are not patentably distinct from each other, because the aspects not specifically covered by the Shieh et al. copending application claims (which are drawn to a method for designing a PSM having a main strip pattern with a PS feature (at a PS of 60% to 100% and an optical transmission of 60% to 100%) at an end of the main strip on a substrate and wherein the main strip is either opaque or semi-transparent) are taught by one or more of AAPA, Okamoto, Hsu, Yang, and/or Chapple-Sokol et al. (each of which is described above). The reasons for applying these references to the instant claims are set forth above.

This is a provisional obviousness-type double patenting (ODP) rejection.

Response to Arguments

The previous objections and rejections not presented above are withdrawn in view of the current amendment including a terminal disclaimer (TD for the Lin US Patent 6,010,807 only) and the accompanying remarks, which are found persuasive.

Applicant's other arguments with respect to currently amended claims 1-19 have also been considered, but they are either unpersuasive or moot in view of the new ground(s) of rejection, as necessitated by the current amendment. This Office action is made FINAL.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is (571)272-1390. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 571-272-1385. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Jsr

**/Mark F. Huff/
Supervisory Patent Examiner, Art Unit 1795**